A Note on Observations of Thermal Habitat Diversity at Channel Rehabilitation and Control Sites in the Trinity River During April 1998.

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Introduction

Habitat diversity, due to flow variation and geomorphic diversity, has been implicated as a major factor influencing bioproduction and biodiversity in river ecosystems (Poff et al. 1997, Richter et al. 1997, Richter et al. 1996a, Richter et al. 1996b, Stanford et al. 1996, Ward and Stanford 1996, Ligon et al 1995). Water temperature, a macrohabitat factor, is generally considered for salmonids which require cold temperatures. However, thermal diversity may be a key factor for many other riverine species, especially as it relates to natural hydrological features. For instance, western pond turtles require slower moving water with higher temperatures (Reese and Welsh 1998). In the Trinity River an experimental approach to increasing habitat diversity has been employed which consists of widening the river by removal of the riparian encroached berm (USFWS 1997, 1994, Evans 1979). Nine sites in the river were rehabilitated between 1988 and 1993. Gallagher (1999), by comparing four of these sites to contemporaneous controls, found that habitat diversity (types and area), weighted usable area for some species, and density of some species and life stages was increased, with increasing flows, by channel rehabilitation. Water temperature and thermal habitat diversity have not been thoroughly examined in the Trinity River.

An aside to the study of channel rehabilitation, thermal diversity, not reported by Gallagher (1999) is reported here. This work was intended as a preliminary study and was conducted because temperature differences were discovered quite by accident during the course of the investigation of fish use and habitat diversity at rehabilitation sites (Gallagher 1999). A major hypothesis under consideration for this study was that channel rehabilitation increased habitat diversity. Micro-habitat was the major focus of the study (Gallagher 1999). However, thermal habitat diversity may be very important to river rehabilitation. This report presents preliminary findings supporting this hypothesis.

Methods and Materials

Gallagher (1999), USFWS (1997), and McBain and Trush (1997) provide detailed descriptions of the study area and the study sites. During the week of 27 April 1998 water temperatures were measured at various locations in the main channel, along the bank, and in off channel areas at four restoration and control sites in the Trinity River California using a YSI temperature and conductivity meter. A data point recorded by Gallagher (1999) as part of an electro-fishing study of fish habitat use in the river was water conductivity. During the week of 27 April 1998, higher water temperatures were noted in an area of the Douglas City channel rehabilitation site. This spurred a quick preliminary check of water temperature along the banks of the rehabilitation and control sites during that week. Two persons, using a YSI temperature probe, worked up the bank at each site measuring water temperatures at a depth of approximately 0.06m in back waters, side channels, off charnels and in the main channel. All temperatures were recorded in the afternoon between 1200 and 1700 hrs. The Lewiston Dam release during this week was 84.3 m^3/s and the Douglas City gage reading was 94.6 m^3/s. Portions of the riparian berm at control sites were inundated.

Results

Air temperatures in the afternoon ranged from 19 to 26 C. At the Buck tail site the water temperature in the main channel was 9.5 C at both the rehabilitation and control sites. Water temperature along the constructed bank of the rehabilitation ranged from 10 to 18 C. Water temperatures downstream along the same bank at the control sites ranged from 11 to 13 C in the flooded riparian zone. Chinook salmon fry and juveniles, other fish species, and yellow legged frogs were observed in the warmer back water areas formed by channel rehabilitation at the Buck tail site. Figure I shows a sketch of the Buck tail site on 27 April 1998. This information was not collected systematically and statistical comparisons are not possible.

Water temperature differences were not as dramatic along the right bank (constructed bank at rehabilitation site) at the Lime Kiln site on 29 April 1998. Main channel water temperature was approximately 10 C. There was a narrow band of 11 to 11.5 C water along the constructed bank at this site. A small area of 12.5 C water was observed at the lower end of the site. Water temperature in the main channel at the Lime Kiln control site was also 10 C. In the back water areas formed by flooding of the riparian berm, water temperatures ranged from 11 to 18 C. In deeper areas thermal stratification was observed. Water at the surface was 18 C and along the bottom it was 13 C. Fish were observed in the wanner thermally stratified areas along the left bank at the Lime Kiln control site. Figure 2 is a sketch of the Lime Kiln rehabilitation and control sites on 29 April 1998.

Water temperature in the main channel at the Douglas City rehabilitation site and just down stream at a non-rehabilitated site was 11 C on 27 April 1998 at 1700 hrs. The rehabilitation site had a large backwater area connected at the top to the main channel by a small side channel. Water temperature in this area ranged from 15 to 21 C. Fish (chinook salmon young-of-the-year) were observed in this back water area. Water flowing at the top of the side channel feeding this backwater was 13 C. There were two other backwater areas formed by cobble bars that had temperatures higher than observed in the main channel. These measurements were 12.5 and 15 C. Downstream of the rehabilitation site in slow water areas along the bank water temperatures were the same as in the main channel (11 C). These areas were associated with the riparian berm and therefore experienced some shading during the day. The types of habitats created by water flowing over the rehabilitation site for this river discharge at the Douglas City rehabilitation site were similar to the Buck Tail site (Fig 1).

Water temperature in the main channel at the Bell Gulch rehabilitation and control sites was between 9.1 and 9.5 C on 30 April 1998 at 1200 hrs. In low velocity areas along the constructed bank at the rehabilitation site water temperatures were between 10 and 11 C. At the control site water temperatures in low velocity areas along the bank were the same as in the main channel. Physical habitat diversity at the Bell Gulch site was similar to the Lime Kiln site (Figs. 2, 3).

Discussion

During the spring, the Trinity River historically experienced high, long duration snow melt flows which inundated cobble bars, riparian areas, and flooded backwaters and off channel areas. These areas probably supplied a mosaic of habitats with different thermal characteristics. The observations presented here support the notion that channel rehabilitation, as employed in the Trinity River, increases thermal habitat diversity by creating low velocity areas which are located off the main channel and experience differential heating. Thus habitat heterogeneity (Ward and Stanford 1995) is further increased. The temperature measurements reported here and the observations of fish (chinook salmon fry, browm trout fry, and stickle backs) and yellow legged frog use of the thermally stratified areas also support this idea. Murphy and Meehan (199 1) suggest that removal of riparian vegetation can have immediate upstream benefits by increasing algae based food production but may limit overall production by cumulatively increasing temperature downstream. This is probably not of particular concern at this time as only a very small portion of the riparian channel has been modified. In addition, water temperatures in the Trinity are strongly controlled by Trinity Dam releases. The finding reported here suggest that small areas of thermally diverse areas are created by rehabilitation at specific sites due to alluvial channel characteristics and bar formation. The finding that main channel water temperatures were the same between rehabilitation and downstream areas suggests that rehabilitation sites are not having a strong effect on main channel temperatures. The thermally diverse habitats we observed potentially provide important habitat for turtles, frogs, native and nonnative fish, and invertebrates. This type of habitat is currently scarce in the Trinity River due to the channeling effect of riparian berms and the effect of Trinity Dam release on water temperature. Shallow water areas with warm temperatures increase growth for young fish while decreasing predation by larger fish (Ward and Stanford 1995). Chapman and Bjom (1969) found that during warmer months young chinook salmon and steelhead shift to faster deeper water as they grow. They also provide evidence of obvious diurnal-nocturnal changes in location for these species. Our findings did not qualify temperatures over time. However, fish at the rehabilitation sites may move and use thermally stratified areas during warmer and/or cooler periods. Diurnal thermal fluctuation in habitats created by inundation of cobble areas of rehabilitation sites may increase temporal habitat heterogeneity in the Trinity River. Thermal heterogeneity provides a mosaic of areas for fish to select from based on their physiological requirements. Thermal diversity may also result in an increase in macro-invertebrate production and diversity. Further experimental evaluation of the temperature aspects of channel rehabilitation in the Trinity River is needed. Diurnal as well as seasonal thermal diversity should be examined at rehabilitation and control sites. Species use of thermally diverse areas and their thermal requirements should also be investigated.

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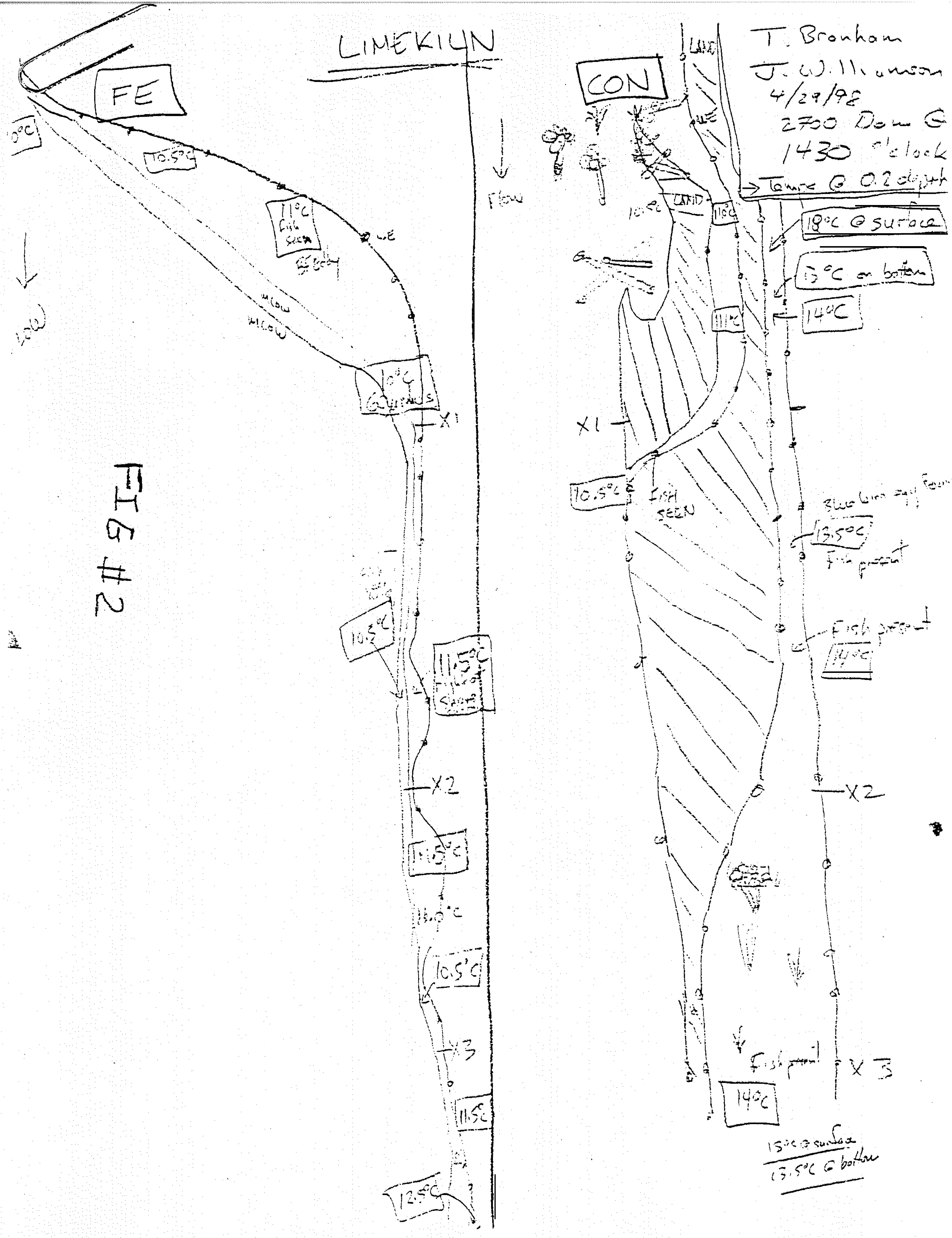
FG #1

4-28-98
Notes: TB
Temp: JW
CFS: 2700
Air Tem 76°F


LIMEKILN
FE
CON
T. Bronham
J. Williamson
4/29/98
2700 Dow G
1430 o'clock
Temps @ 0.2 depth
18°C @ surface
13°C on bottom
14°C
10°C
10.5°C
11°C
Fish Seen
Eddy
Flow
10°C
X1
X2
X3
10.5°C
11.5°C
11.5°C
11.0°C
10.5°C
11.5°C
12.5°C
LAND
11°C
10.5°C
11°C
10.5°C
FISH SEEN
13.5°C
Fish present
Fish present
14°C
Fish pool
14°C
15°C @ surface
13.5°C @ bottom
FIG #2

Bell Gulch FE H_2O temp measurement 4/30/98 @ 1200

Air temp ~72.

1 CPE dry temp 11°C depth 0.2 vel < 0.5
2 mutin chanl temp 9.5°C depth .5 vel < 0.5
3 CFEW depth 0.2 temp 10°C vels < 0.2
4 mcow 2 temp 9.5 Depth 0.4 vels 1–1.5.
5 GC Ew temp 10°C Depth 0.2 waves

6 mcow 3 temp 9.9 Depth 0.3
7 CPEW temp 10°C Depth 0.2 waves

8 mcow 2 temp 9.5°C Depth 0.4 vel ~1.5

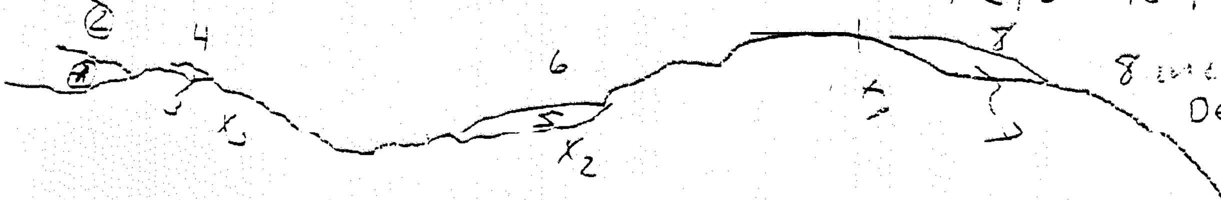
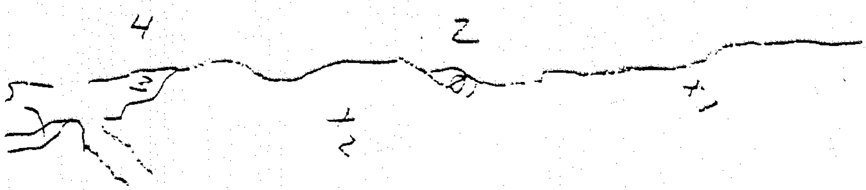


Fig #3

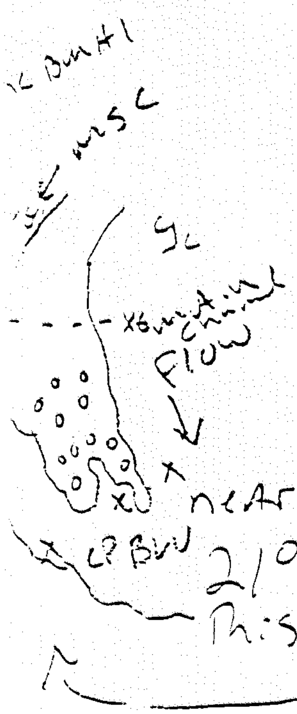
Bell Gulch control
0 CCEW temp 9.5°C Depth 0.2 waves
2 mcow 1 temp 9°C Depth 0.5
3 CFEW temp 9.5°C Depth 0.2 vels < 0.2
4 mcow 2 Depth 0.4 temp 9.1°C vels ~ 0.5
5 CPEW temp 9.5°C Depth 0.2 vels < 0.1



Appendix #1

340°

1650 hrs 4/27/98 D6FE



H_2O temp main channel ~0.8 f/s
= 11°C measured ~ 10' out into current Depth ~0.4

BACK H_2O ~~of~~ connected to channel at top
Through a flowing MSC H_2O temp here is
15°C. This is on near River side of
BACK H_2O CPBW. no flow here Depth ~0.3
near BANK edge of same BACK H_2O water temp is
21°C! This is just ds of where MSC flows into
This CPBW X's mark Location of temp measurements!
Low to zero flow here. Depth 0.2

In CPBW fish observed

Y1 = top of MSC H_2O temp 13°C flow ~0.2 f/s

Y2 = 10' out in main channel H_2O temp 11°C flow <0.5 f/s
This Area Between X 7 3 US of X 6 DS of McBain Bm #1

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main flow

CPBW US of XSec #5 H_2O temp = 12.5°C no flow waves
unit is 7 x 7 ft. Main flow H_2O temp = 10.5° flow <0.5 f/s Depth 0.4 f.

CPBW just DS of XSec #2 H_2O temp in CPBW = 15°C waves
But no flow unit is 12 x 20 ft. Depth 0.2 ft
x main channel H_2O temp = 11°C taken ~ 10 ft into channel
~ @ flow of <0.5 f/s Depth ~0.4 ft

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tree

DS of FE @ Flow Study XSec 3 LgFEW no flow waves
Depth 0.2 f 11°C H_2O temp

DS of FE flow Study XSec #5 BAKFEW 0 flow waves
H_2O temp = 11°C Depth 0.2 ft.

BAKPBW DS flow study X2 near old camp spot formed with MSC
above H_2O temp is 11.2°C
Temp measured with YSI 33 S-C-T meter